

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	1	("6214724").PN.	US-PGPUB; USPAT	OR	OFF	2006/01/25 09:26
L2	1	("6297539").PN.	US-PGPUB; USPAT	OR	OFF	2006/01/25 09:31
L3	677	ALD with cycles	US-PGPUB; USPAT	OR	ON	2006/01/25 10:24
L4	256	3 and ((doped or implanted) with (silicon or polysilicon))	US-PGPUB; USPAT	OR	ON	2006/01/25 10:23
L5	157	4 and capacitor	US-PGPUB; USPAT	OR	ON	2006/01/25 09:35
L6	75	5 and @ad<"20030312"	US-PGPUB; USPAT	OR	ON	2006/01/25 10:33
L7	39	6 and (silicide or salicide)	US-PGPUB; USPAT	OR	ON	2006/01/25 09:37
L8	2320	ALD same cycles	USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2006/01/25 10:23
L9	3	8 and ((doped or implanted) with (silicon or polysilicon))	USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2006/01/25 10:24
L11	8	((ALD or (atomic adj layer adj deposition)) and cycles and thickness and silicide and (titanium or tantalum or hafnium or tungsten) and (silicon or polysilicon)).clm.	US-PGPUB; USPAT	OR	ON	2006/01/25 10:30
L13	67	438/244,253,396,630,649.ccls. and (ALD or (atomic adj layer adj deposition)) and cycles	US-PGPUB; USPAT	OR	ON	2006/01/25 10:33
L14	38	13 and @ad<"20030312"	US-PGPUB; USPAT	OR	ON	2006/01/25 10:33
L15	27	14 not 6	US-PGPUB; USPAT	OR	ON	2006/01/25 10:34

DOCUMENT-IDENTIFIER: US 20020025628 A1

TITLE: Capacitor fabrication methods and capacitor constructions

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Detail Description Paragraph - DETX (3):

[0018] **Atomic layer deposition (ALD)** involves formation of successive atomic layers on a substrate. Such layers may comprise an epitaxial, polycrystalline, amorphous, etc. material. **ALD** may also be referred to as atomic layer epitaxy, atomic layer processing, etc. Further, the invention may encompass other deposition methods not traditionally referred to as **ALD**, for example, chemical vapor deposition (CVD), but nevertheless including the method steps described herein. The deposition methods herein may be described in the context of formation on a semiconductor wafer. However, the invention encompasses deposition on a variety of substrates besides semiconductor substrates.

Detail Description Paragraph - DETX (5):

[0020] Described in summary, **ALD** includes exposing an initial substrate to a first chemical species to accomplish chemisorption of the species onto the substrate. Theoretically, the chemisorption forms a monolayer that is uniformly one atom or molecule thick on the entire exposed initial substrate. In other words, a saturated monolayer. Practically, as further described below, chemisorption might not occur on all portions of the substrate. Nevertheless, such an imperfect monolayer is still a monolayer in the context of this document. In many applications, merely a substantially saturated monolayer may be suitable. A substantially saturated monolayer is one that will still yield a deposited layer exhibiting the quality and/or properties desired for such layer.

Detail Description Paragraph - DETX (7):

[0022] Purging may involve a variety of techniques including, but not limited to, contacting the substrate and/or monolayer with a carrier gas and/or lowering pressure to below the deposition pressure to reduce the concentration of a species contacting the substrate and/or chemisorbed species. Examples of carrier gases include N.sub.2, Ar, He, Ne, Kr, Xe, etc. Purging may instead include contacting the substrate and/or monolayer with any substance that allows chemisorption byproducts to desorb and reduces the concentration of a contacting species preparatory to introducing another species. A suitable

amount of purging can be determined experimentally as known to those skilled in the art. Purging time may be successively reduced to a purge time that yields an increase in film growth rate. The increase in film growth rate might be an indication of a change to a non-ALD process regime and may be used to establish a purge time limit.

Detail Description Paragraph - DETX (8):

[0023] ALD is often described as a self-limiting process, in that a finite number of sites exist on a substrate to which the first species may form chemical bonds. The second species might only bond to the first species and thus may also be self-limiting. Once all of the finite number of sites on a substrate are bonded with a first species, the first species will often not bond to other of the first species already bonded with the substrate. However, process conditions can be varied in ALD to promote such bonding and render ALD not self-limiting. Accordingly, ALD may also encompass a species forming other than one monolayer at a time by stacking of a species, forming a layer more than one atom or molecule thick. The various aspects of the present invention described herein are applicable to any circumstance where ALD may be desired. Often, traditional ALD occurs within an often-used range of temperature and pressure and according to established purging criteria to achieve the desired formation of an overall ALD layer one monolayer at a time. Even so, ALD conditions can vary greatly depending on the particular precursors, layer composition, deposition equipment, and other factors according to criteria known by those skilled in the art. Maintaining the traditional conditions of temperature, pressure, and purging minimizes unwanted reactions that may impact monolayer formation and quality of the resulting overall ALD layer. Accordingly, operating outside the traditional temperature and pressure ranges may risk formation of defective monolayers.

Detail Description Paragraph - DETX (9):

[0024] The general technology of chemical vapor deposition (CVD) includes a variety of more specific processes, including, but not limited to, plasma enhanced CVD and others. CVD is commonly used to form non-selectively a complete, deposited material on a substrate. One characteristic of CVD is the simultaneous presence of multiple species in the deposition chamber that react to form the deposited material. Such condition is contrasted with the purging criteria for traditional ALD wherein a substrate is contacted with a single deposition species that chemisorbs to a substrate or previously deposited species. An ALD process regime may provide a simultaneously contacted plurality of species of a type or under conditions such that ALD chemisorption, rather than CVD reaction occurs. Instead of reacting together, the species may chemisorb to a substrate or previously deposited species, providing a surface

onto which subsequent species may next chemisorb to form a complete layer of desired material. Under most CVD conditions, deposition occurs largely independent of the composition or surface properties of an underlying substrate. By contrast, chemisorption rate in ALD might be influenced by the composition, crystalline structure, and other properties of a substrate or chemisorbed species. Other process conditions, for example, pressure and temperature, may also influence chemisorption rate.

Detail Description Paragraph - DETX (10):

[0025] ALD, as well as other deposition methods and/or methods of forming insulative barrier layers may be useful in capacitor fabrication methods. According to one aspect of the invention, a capacitor fabrication method includes forming a first capacitor electrode over a substrate and atomic layer depositing an insulative barrier layer to oxygen diffusion over the first electrode. A capacitor dielectric layer may be formed over the first electrode and a second capacitor electrode may be formed over the dielectric layer. At least one of the first or second electrodes may comprise polysilicon, which may be rugged polysilicon, preferably hemispherical grain (HSG) polysilicon. Also, at least one of the electrodes might comprise RuO<sub>2</sub>. The dielectric layer may comprise oxygen. Exemplary materials for the dielectric layer include, but are not limited to, Ta<sub>2</sub>O<sub>5</sub>, barium strontium titanate, TiO<sub>2</sub>, Y<sub>2</sub>O<sub>3</sub>, HfO<sub>2</sub>, ZrO<sub>2</sub>, HfSiO<sub>2</sub>, ZrSiO<sub>2</sub>, etc.

Detail Description Paragraph - DETX (18):

[0033] Although ALD and/or chemisorbing the first and second precursors may be suitable for forming a barrier layer, other methods may also be suitable. Accordingly, a variety of barrier layer forming techniques may be used in combination with techniques to increase electrode surface area to provide enhancement of capacitance per unit area. FIGS. 1-6 exemplify the features of the various aspects of the invention described above, as well as other aspects of the invention. For example, enhancing capacitance per unit area.

Detail Description Paragraph - DETX (19):

[0034] Turning to FIG. 1, wafer portion 1 is shown including a substrate 2 with an insulative layer 4 formed thereon. A capacitor fabrication method may include forming an opening 16 in insulative layer 4, the opening 16 having sides and a bottom. Turning to FIG. 2, a layer of polysilicon 6 may be formed over the sides and bottom of the opening. Polysilicon layer 6 may then be converted to a first capacitor electrode 8 comprising hemispherical grain polysilicon, as shown in FIG. 3. In FIG. 4, an insulative barrier layer 10 may be conformally formed on first electrode 8. Barrier layer 10 may comprise Al<sub>2</sub>O<sub>3</sub> and be sufficiently thick and dense to reduce oxidation of the

first electrode by oxygen diffusion from over barrier layer 10. A capacitor dielectric layer 12 may be formed on barrier layer 10. One source of oxygen diffusion may be dielectric layer 12. In FIG. 5, a second capacitor electrode layer 14 is shown formed on dielectric layer 12. FIG. 6 shows excess portions of barrier layer 10, dielectric layer 12, and second capacitor electrode layer 14 removed from over insulative layer 4 to form a capacitor structure. As described above, a barrier layer may also be formed over a dielectric layer, thus FIG. 7 alternatively shows barrier layer 10 over dielectric layer 12. As an example, Al.sub.2O.sub.3 deposition from TMA/H.sub.2O was conducted at a substrate temperature from about 300 to about 500.degree. C. and chamber pressure of about 200 mT using a GENUS LYNX 2 (TM) ALD tool. The GENUS LYNX 2

(TM) tool controls gas flow rate using pressure settings. The first step of the cycle included pulsing H.sub.2O set at about 20-25 T for from about 200 to about 2000 microseconds (.mu.sec) in a N.sub.2 carrier set at about 40 T. A N.sub.2 carrier set at about 74 T was pulsed for from about 1 to about 3 sec to purge the H.sub.2O. Next, TMA set at about 20-25 T was pulsed for from about 80 to about 1000 .mu.sec in a N.sub.2 carrier set at about 40 T followed by purging as indicated to complete the cycle. Gases were removed using an exhaust pump. The Al.sub.2O.sub.3 formed exhibited a K factor of approximately 9.